Bulletin 306 (Revised March 1937) September 1934

Diseases and Insects of Small Fruits

C. R. Crosby, W. D. Mills, and J. A. Evans

IMPERIAL MYCOLOGICAL
11 AUG. 1937
INSTITUTE

Cornell Extension Bulletin

Published by the New York State College of Agriculture
at Cornell University, Ithaca, New York

L. R. Simons, Director of Extension Service

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First printing, September 1934
Second printing, March 1937

DISEASES AND INSECTS OF SMALL FRUITS

C. R. Crosby, W. D. Mills, and J. A. Evans

The purpose of this bulletin is to give growers of small fruits the latest information available on the control of the diseases and insects affecting these crops. Much of this material has been published elsewhere but is not readily available to growers. Considerable additional information has been obtained from unpublished data of the research workers of the state experiment stations.

Hugh Glasgow, F. Z. Hartzell, W. H. Rankin, L. M. Cooley, and F. E. Gladwin of the New York State Agricultural Experiment Station at Geneva, New York, have been especially helpful in furnishing information and in making suggestions as to the best methods of control. Many valuable suggestions have also been received from the county agricultural agents in those counties where the growing of small fruits is an important enterprise.

RASPBERRIES AND BLACKBERRIES

Both raspberries and blackberries are subject to crown gall, anthracnose, rust, and leaf-spot. Raspberries are also subject to the following diseases: wilt, powdery mildew, spur-blight, the mosaics, leaf-curls, and streaks. The most serious insect pest of raspberries is the fruit worm; and the red-spider is frequently serious on both blackberries and raspberries. The cane-borers often attract attention but are not likely to cause serious loss.

MOSAICS

(Caused by viruses)

The two mosaic diseases are so prevalent in all species of raspberries that every grower should consider their control as a necessary part of his cultural practices for maintaining vigor and yields. Affected plants are systemically diseased, never recover, degenerate at a variable rate depending on variety and cultural conditions, and as long as they live are a source of spread to healthy plants. The spread of these maladies within a raspberry planting results in a constantly diminishing stand of plants, a marked reduction not only in yield but in quality of fruit, and a much shortened profitable life of the field—a process familiar to berry growers for many years as "running-out."

Symptoms by which mosaic plants can be identified differ according to species and variety, and seasonal and cultural conditions. In general, the

presence of a mosaic virus within a raspberry plant is expressed by mottling of the leaves. Also, the leaves may be misshapen, blistered, and dwarfed in size. Leaf symptoms are most noticeable in the spring and early summer. In addition, more or less stunting of cane growth is evident in affected plants. In black varieties, new canes may die back at the tips in mid-summer. A more complete description of mosaic symptoms, with illustration, is given in *Raspberry Growing in New York,* Circular 153 of the New York State (Geneva) Agricultural Experiment Station.

Control

One method to prevent losses from raspberry mosaics is to grow only varieties that are either mosaic-escaping or mosaic-resistant. Among present-day commercial varieties of red raspberries, Newburgh and Chief seldom become infected, while Latham, although prone to infection, resists the effects of mosaic notably when kept under good culture. None of the black or purple raspberry varieties with horticultural merit escape infection by the mosaic viruses to any considerable extent. The Columbian purple variety is entirely infected with one mosaic virus but possesses such high resistance that it is grown successfully nevertheless. No highly mosaic-resistant black raspberry varieties are also productive and of good quality.

With most varieties of raspberries, mosaic losses can be kept down only by a definite three-point program of disease prevention:

1. All new plantings should be made with as nearly a mosaic-free stock as can be obtained. Since mosaic infections cannot be recognized in dormant plants, the only means of knowing the character of the planting stock is to know the conditions existing in the "parent" field during the previous growing season.

2. Such stock should be planted as far away as possible from other raspberries in which mosaic is present. Most wild red raspberries in every section of the State are mosaic-infected and, consequently, are a serious menace to healthy cultivated raspberries. The minimum distance of healthy stock from both wild and cultivated infection sources should be 25 or 30 rods, and double that distance is highly desirable.

3. Plantings that contain but little mosaic originally and are well isolated should be inspected regularly, and diseased plants taken out during at least their first and second years. If the mosaic content remains low, inspection and roguing can be continued profitably for several years. Three inspections each year are advised in black and purple raspberries about (1) late May or early June, (2) July, and (3) late September or early October. Two inspections are advised for red raspberries: in mid-June and in late September or early October. In both species, the spring in-

spection, when symptoms are expressed clearly, is the most important single one. Diseased plants should be removed promptly on discovery, and in such a manner as not to shake off any aphids. Scorching foliage with a fire torch prior to digging affected plants is an excellent precaution. If this is not possible, digging after heavy rains, which will have dislodged and drowned many of the aphids, is a good practice. With black and purple raspberries only the crowns need be dug, but with red raspberries the entire root systems should be grubbed out. The efforts of inspection and roguing which eliminate internal infection sources are worthwhile only if the isolation of the planting is adequate. If mosaic spreads in from external sources as rapidly as infected plants are removed, inspection and roguing results only in a loss of plant stand without accomplishing any benefit.

Control of mosaics by spraying or dusting to kill the aphids has not proved practical. Elimination of infection sources, making aphid populations of little significance, is much more economical and beneficial.

Special precaution should be taken to isolate plantings of susceptible raspberry varieties, particularly of the black species, from cultivated plantings of varieties such as Latham and Columbian which are mosaic-resistant but are apt to be heavily infected and ruinous to susceptible sorts.

STREAKS

(Caused by viruses)

Black raspberries, and occasionally blackberries, are subject to two virus maladies known as *mild streak* and *severe streak*. Mild streak is more common in the Finger Lakes section, and severe streak in the Chautauqua fruit belt.

Symptoms of the streak diseases are usually expressed only during the warmer summer months. Both can be first detected by a typical hooking or recurling of the tip leaflets on the new shoots. Mild streak does not dwarf cane growth or mottle the foliage, and causes only very narrow, light, gray-blue streaks on the main and later canes. Streak produces a marked splotching of foliage, heavy blue streaks on canes, and considerable cane dwarfing. Both diseases particularly affect the fruits, causing them to be dry, gray, and insipid.

The natural means by which the streak diseases are spread are not yet known. Experience in Ohio, Pennsylvania, and New York all indicate strongly that epidemics of streak in black raspberries are associated in some way with the presence of wild or cultivated blackberries (even though healthy) in the vicinity.

The prinicipal control measures are to obtain planting stock free of

streak and never to plant it near infected black-raspberry stock. If there is likely to be some streak inoculum in the black-raspberry planting stock, then one should never plant it near wild or cultivated blackberries.

LEAF CURLS

(Caused by viruses)

Two viruses cause the leaf-curl maladies in raspberries, and the symptoms they produce are similar. One is restricted to red raspberries, being especially common in the Cuthbert variety, while the other affects both red and black raspberries. The Plum Farmer black raspberry, however, is immune to curl.

Leaf-curl diseases are comparatively rare in New York. Their symptoms are pronounced throughout the entire growing season, and affected plants can be readily detected. The leaves are dark green, crinkled, and rolled down at the margins. The canes are dwarfed severely.

The small raspberry aphid carries the disease from infected to healthy plants. This aphid is inactive and clings tightly to its host. Digging affected plants, without particular precautions, as soon as foliage is produced in the spring will keep this disease well under control.

RASPBERRY FRUIT-WORM

(*Byturus unicolor* Say)

The raspberry fruit-worm, or American raspberry beetle as it is sometimes called, is widely distributed throughout the Northern United States and Canada. Although it attacks black and purple raspberries, it is most injurious to red raspberries, especially to early varieties. Recently it has become a serious pest on loganberries in the Northwest.

The beetle is about 1/7 inch in length, light brown in color, and slightly hairy. The beetles appear on the plants in May as the new foliage is unfolding and feed on the buds and tender leaves, later attacking the blossoms themselves. The leaves become riddled with holes and often the blossoms are so badly injured that the crop is practically destroyed.

The beetles deposit their whitish oval eggs on the green berries, on the blossom stems and leaf petioles, usually so well hidden among the plant hairs that it is difficult to detect them. On hatching, the young grubs enter the blossom buds or young fruits where they feed on the fleshy receptacle. Some of the infested fruits dry up before ripening, others decay, and many others at picking time contain a larva lying between the berry and the receptacle. Many of these larvae are gathered with the berries and are overlooked until the fruit is served. The full-grown larva is about ¼ inch in length, yellowish white in color, and sparsely clothed with transverse rows

of stiff, light-colored hairs. When mature the larvae fall to the ground where just below the surface they construct earthen cells in which to pupate. In some years, at least part of the grubs reach the adult stage before the advent of winter but the beetles remain in the pupal cells until the following spring.

Control

The damage caused by the raspberry beetle is of two kinds: destruction of the buds by the beetles and the loss resulting from the presence of the larvae in the berries. Prevention of both kinds of injury is difficult because the plants are likely to be injured by too many applications of spray.

The presence of the larvae of the raspberry beetle in the berries may be largely prevented by spraying with 4 pounds of lead arsenate, and either 1 pound of casein spreader or 1 pound powdered skimmilk, in 100 gallons of water. The first application should be made about 10 days before the beginning of blossoming; the second just as the first blossoms begin to open.

If a dust is used, an 85–15 hydrated-lime–lead-arsenate mixture is indicated. A second application should be made in about ten days, and dusts should be renewed after rains.

The use of lime-sulfur, sulfur dusts, bordeaux mixture, or calcium arsenate is not advised, as these materials may cause injury to the foliage.

To protect the buds from destruction by the beetles, it would be necessary to start spraying much earlier than indicated. The first application should be made soon after the beetles appear and begin feeding on the foliage. This is usually about the first week in May in the Hudson Valley and about one week later in western New York, although the exact time will vary from year to year depending upon seasonal developments. Where a spray is applied early for the beetles and only two applications are to be made, the second application should be made about one week before the bloom. It is not usually possible to make more than three spray applications without injury to the plants and sometimes two is all that can be made with safety. In heavy infestations the plants may not be able to stand enough applications to protect the buds from the beetles and also to prevent the presence of the larvae in the berries. The grower, therefore, should decide whether it is more important to obtain a large early crop by protecting the buds or to have the berries free from worms and to plan his spray schedule accordingly.

RED-SPIDER

(*Tetranychus telarius* Linnaeus)

The red-spider is discussed on page 14 as a strawberry pest. On raspberries and blackberries these mites often cause important injury, especi-

ally in hot, dry seasons. The mites are found on the under side of the leaves where their feeding causes the foliage to turn yellowish brown and, in severe cases, to dry up and fall off. The size of the crop is decreased and the quality of the fruit impaired. When abundant, the mites may swarm onto the berries in countless numbers at picking time. Their presence on the fruit in the market is objectionable.

Heavy infestations of the red-spider also leave the plants more susceptible to winter injury. Plants that are kept in a good vigorous condition by proper cultural practices are able to withstand the attack of the mites much better than plants in a poor state of vigor.

Control

Recent experiments indicate that good control of the red-spider on raspberries can be obtained by spraying with 1 gallon of summer or white oil in 100 gallons of water. The material must be applied with high pressure and the spray directed upward so as to hit and wet the mites on the under side of the leaves. Best control is obtained if the mites are controlled before they spread to the fruit.

WILT

(Caused by *Verticillium alboatrum* McA.)

Wilt is a disease that may occur in new plantings of black or red raspberries, if the wilt fungus is present in the soil. Raspberries should not follow such crops as tomatoes, potatoes, eggplant, and others of this group, which may infest the soil with the wilt fungus. If only a small amount of wilt shows in the new raspberry planting it need not be assumed that it will be a failure, for usually the trouble disappears rapidly and affected plants may recover. The red varieties outgrow this disease more successfully than do the black varieties

A broad blue stripe usually develops on the side of the new canes and the leaves are shed from the base upward. Such canes usually die.

POWDERY MILDEW

(Caused by *Sphaerotheca humuli* (Fr.) Burr.)

Powdery mildew occurs in raspberries, but it is of commercial importance only on the Latham variety of red raspberries. It first becomes apparent on the tips of the new canes after they have reached a height of 2 or 3 feet. The tip leaves are dwarfed in size, mottled, and distorted, resembling in many respects red mosaic. The under surface of the leaves shows a water-soaked appearance or a white coating which serves to identify it

as powdery mildew. The tips make a sharp spike-like growth of a few inches in severe cases and then are permanently halted in growth. Observation indicates that this disease is not likely to occur in New York if the planting is situated so that the air circulates freely on all sides. There are no direct control measures and a heavy infection one year may be followed by complete absence the next.

PURPLE CANE SPOT

(Caused by *Mycosphaerella rubina* (Pk.) Jacz.)

The purple-cane-spot disease is very common ailment of red raspberries. The spots are large and are conspicuous on the green canes by early autumn. The disease is also called *spur blight* because the buds are injured where the spots occur and the fruiting laterals formed the next spring are apt to die. If the spots completely girdle the cane, breakage often follows in the fruiting season.

Control

Clean culture, narrow rows, proper spacing of canes by thinning, and locations favorable for good air drainage give practical control of this disease. If the grower fails to provide these conditions, spraying the new canes in late spring with bordeaux 8–12–100 and a sticker may be necessary to hold the disease in check. Two applications are advised, the first when the new canes have reached a height of about 1 foot and the second two weeks later. Care should be taken to direct these sprays at the new canes only, since injury often results from either bordeaux or sulfur mixtures if applied to the fruiting cane foliage.

RASPBERRY CANE-BORER

(*Oberea bimaculata* Olivier)

The adult is a small long-horned beetle, black with the prothorax yellow. The beetles appear in June and the female deposits her eggs singly in the pith of the new growth about 6 inches from the tip of the cane. She first makes two rows of punctures around the cane about half an inch apart and inserts her egg near the lower row. This girdling causes the top to wilt. The egg hatches early in July and the larva burrows slowly towards the base of the cane, passing the winter within an inch or two of the girdle. The second season it continues its burrow through what is then the bearing cane and usually kills it before the fruit matures. The second winter is spent in the cane near the ground. The beetle emerges the following spring.

Control

The wilted tips are easily seen. They should be cut off below the lower girdle and destroyed. Since the insect breeds in wild raspberry plants they should not be permitted to grow near commercial plantings.

RED-NECKED CANE-BORER

(*Agrilus ruficollis* Fabricius)

Irregular swellings, or galls, from 1 to 3 inches in length on the new canes of blackberry, dewberry, and raspberry indicate the presence of this borer. The adult is a small beetle about 1/3 inch in length; the wing covers are black, the thorax coppery, and the head black. The beetles are active during June and July. The female deposits her eggs singly in the bark near the base of a leaf on the new growth. The young larva first burrows in the sap wood spirally around the stem two to six times, thus girdling the cane and causing the gall to develop. It then enters the pith where it passes the winter in a partly grown condition. The next spring it completes its growth and the transformation to the beetle takes place from late May till July. There is only one generation a year.

Control

This pest may be controlled by cutting out and burning all infested canes during the dormant period of the plants. This work can be done best while pruning the bushes. All wild or neglected berry bushes near commercial plantings should be destroyed.

BLACKBERRY LEAF-MINER

(*Metallus rubi* Forbes)

Near Lake Erie blackberries are subject to attack by a sawfly leaf-miner. The injury to the foliage from heavy infestations weakens the plants and causes poorly developed fruits of inferior quality. In this region many plantings have been abandoned because they became too weak to produce profitable crops.

The adult sawfly is nearly black and about 1/6 inch in length. Two broods of adults appear each season; the first in late May or early June, the second in late August. The female sawfly inserts her eggs singly in the tissue of the leaf. The eggs of the first brood hatch in about two weeks. The larva feeds between the two layers of the leaf excavating a rather large blotched mine; three or four mines may occur in a single leaf. The injured part of the leaf turns brown and dies; in severe cases the whole field has the appearance of having been singed by fire. When full-grown, the larvae abandon the leaves and enter the ground for pupation. The injury caused by the second brood becomes evident in late August and September.

Control

No satisfactory method of control for the blackberry leaf-miner has been devised. About half of the larvae can be killed in the mines by spraying with a high-grade summer oil (4 gallons of the emulsion in water to make 100 gallons). The application should be made soon after the mines become the size of a five-cent piece.

CROWN GALL

(Caused by *Bacterium tumefaciens* E. F. Smith and Townsend)

Bacterial galls occur commonly in all brambles. The typical crown gall affects the roots and crowns. A second unnamed species of bacterium is the cause for galls on the canes and crowns. The cane gall is more prevalent in black and purple raspberries while the root gall affects red raspberries and blackberries. Both types of gall interfere with food and water conduction. Where serious, the production of new shoots is much reduced. The galls may be very small swellings or large lumps roughened with nodules on the surface. The microbes which cause these diseases live over winter in the soil.

Control

Brambles should not be planted on soil known to have grown berries, vines, or fruit trees showing crown galls until several years have elapsed. If possible, new planting stock should come from a field known to be free of galls. At least, the new planting stock should be carefully examined at planting time and the plants with galls discarded.

ANTHRACNOSE

(Caused by *Gloeosporium venetum* Speg.)

Anthracnose, also called *the cane-spot disease,* frequently causes injury to black and purple raspberries and to blackberries. This disease becomes serious when frequent rains in the spring result in a heavy infection of the lower parts of the new green canes. At each purple spot, with its gray center, green bark is destroyed and when the spots are numerous the cane is girdled. Dwarfing and even death of the new canes may occur. The fungus may also spread to the fruiting laterals and to the blossom stems and leaves, causing the fruit to dry up before ripening. Thus a heavy infection may cause the loss of two seasons' crop.

Control

This disease is largely controlled by modifying the cultural practices. The grower should avoid bringing the fungus into the new planting.

Rooted tips for the new planting should be dug and planted while they are completely dormant. Leaving the rooted tips attached to the canes in the fruiting block until new canes are sent up is a very poor practice. In addition to planting dormant roots, the handle should be cut from the set. Leaving the handle attached allows the fungus to spread in the new planting from any cane spots that may be on it. In addition to these precautions, rigid clean culture will help to keep the cane-spot disease under control by allowing quick drying of the canes after rains. In fruiting blocks in which this disease has obtained a foothold, one application of lime-sulfur, 1–10, applied at the time the new leaves are just appearing on the old canes, is a valuable control measure. No later applications of any fungicide are advisable because of likely injury to the fruiting cane foliage.

ORANGE RUST

(Caused by *Gymnoconia interstitiales* (Schl.) Lag.)

This disease is serious only in black raspberries and in blackberries. It causes a complete loss of crop on the diseased plants. The rust fungus lives over from year to year in the affected plants. The first leaves appearing in the spring are yellowish on the under side. A little later the yellowish blisters break, spreading the bright yellow-orange spores of the rust fungus. Rusted plants develop large numbers of spindly canes which bear very few prickles and deformed leaves.

Control

The affected plants should be dug up and burned before the orange spores are released from the blisters, since they are the means of spreading the disease.

The orange rust may be confused with two other rusts which occur on red raspberries later in the season. These rusts do not live over in the plants, and eradication is not advisable.

LEAF SPOT

(Caused by *Septoria rubi* Westd.)

The common small purple spots on the leaves of all brambles are caused by the leaf-spot fungus. Although conspicuous, this disease is only serious when considerable leaf drop occurs.

Control

In varieties and locations where considerable leaf drop has occurred, precautions against winter injury such as the use of cover crops should be taken. A more complete discussion of winter injury and its prevention is

given in *Raspberry Growing in New York State: Cultural Practices and Disease Control,* Bulletin 625 of the New York State [Geneva] Agricultural Experiment Station.

STRAWBERRIES

The most common diseases affecting strawberries are leaf-spot, powdery mildew, and root-rots. Yellows has also attracted considerable attention recently. In some localities the weevil has been a serious pest. The leaf-roller is generally distributed but is rarely serious in New York. Root worms and white grubs are likely to become abundant in old plantings.

STRAWBERRY WEEVIL

(*Anthonomus signatus* Say)

The strawberry weevil has chiefly been serious in the Hudson Valley but in recent years it has become a problem in some plantings in western New York. The insect is a very small snout-beetle, almost black to reddish brown in color, and only about 1/10 inch in length. It hibernates in the adult stage in rubbish, especially in woodlots or hedgerows adjoining strawberry fields. The beetles appear on the strawberry plants as soon as the blossom buds put forth in the spring. The beetle deposits an egg in an unopened bud and then causes it to fall by cutting the pedicel. In this way the crop may be seriously reduced. Occasionally half or more of the buds may be destroyed. The Dorsett and Fairfax varieties appear to be more susceptible than the Howard (Premier).

Control

In localities where the weevil is troublesome it is not a good plan to plant strawberries next to woodlots or to tolerate hedgerows or overgrown fences near-by. Such cover offers excellent hibernating shelter for the weevils and makes it more difficult to protect the crop from their attacks.

The best results in controlling the weevil have been obtained by dusting with a poison. A mixture of 1 pound of lead or calcium arsenate and 4 pounds of hydrated lime has given good results. The first application should be made as soon as the beetles begin to cut the bud stems. The dust is applied with a hand-duster at the rate of about 15 pounds to the acre. The dust is most effective if applied in the morning of a warm sunny day because the beetles are more active under such conditions. Under New York conditions one dusting is sufficient, but if the dust is removed by rain soon after being applied, a second application should be made at once to renew the covering. While liquid sprays do not appear to be so effective as dusts, the following formula may be used if the grower cannot use a dust.

Arsenate of lead (or calcium arsenate)	3 pounds
Hydrated spray lime	3 pounds
(Use 9 pounds of lime with calcium arsenate)	
Water to make	100 gallons

Arsenicals should not be applied after the fruits begin to form.

RED-SPIDER

(*Tetranychus telarius* Linnaeus)

In some parts of the State, especially on Long Island, strawberries are subject to injury by heavy infestations of the common red-spider of the greenhouse. The red-spider is a very small mite but considerably larger than the cyclamen mite. It varies in color from pale greenish yellow to dark crimson red, and is usually marked with two dark spots on the side of the body. The minute, elongate, transparent eggs are to be found on the under side of the leaves. Multiplication is rapid and, with favorable weather conditions, the mites often become so numerous as to seriously injure the plants before the crop is harvested.

Control

On strawberries the most practical method of control seems to be the use of a very finely ground sulfur dust. The dust should be applied evenly with a good duster so that the sulfur will reach the mites on the under side of the leaves and not accumulate on the foliage where it might cause injury. The application should be made on a warm day when there is little wind. This treatment may cause considerable injury to the plants if applications are made during or preceding periods of excessive heat.

CYCLAMEN MITE

(*Tarsonemus pallidus* Banks)

Strawberries are sometimes attacked by a minute whitish mite that causes the plants to appear stunted and unhealthy with the leaves curled and distorted. This condition reduces the size and quality of the crop. This trouble is sometimes called *crinkle leaf* by growers. This condition reduces the size and quality of the crop.

Control

No practical method has been devised for controlling the mites on plants in the field. If it is suspected that new plants are infested, they may be freed of the mites by immersing them for 30 minutes in water at a temperature of 110° F. They should not be treated in bundles but should be placed

loose in trays before submerging them in the water. It is very important that the water be kept at a constant temperature during the treatment.

LEAF-SPOT

(Caused by *Mycosphaerella fragariae* (Schw.) Lindau)

All strawberry growers are familiar with the purple-bordered gray spots occurring commonly on strawberry leaves. This disease is serious when spots are abundant and cause scorching of the leaves or when fruit stems are attacked. Leaf-spot has been largely eliminated as a serious disease of strawberries through the use of more resistant varieties. The Premier variety is outstanding in its freedom from injury by leaf-spot, particularly if the bed is only fruited one year.

The William Belt is one of the high-quality varieties which is no longer grown commercially because of its susceptibility to leaf-spot.

Control

The commercial practice of fruiting strawberry beds for only one year is the best practical method of control. The location of the bed in respect to good air drainage and sunshine for quick drying of the plants will reduce the danger of serious infection. If it is decided to hold beds over for a second fruiting year, some benefit may be obtained by mowing and burning the foliage after picking. Some experimental data indicate that a seasonal program of 6–6–100 bordeaux mixture is effective in leaf-spot control, but the practical value of such a program for the commercial grower has not yet been demonstrated in this State.

POWDERY MILDEW

(Caused by *Sphaerotheca humuli* (Fr.) Burr.)

Powdery mildew is readily recognized by the curling upward of the leaf margins and the scorching of these leaves. Before the curling of the leaves a very slight silvery appearance on the under surface shows the presence of the mildew fungus. Conditions favoring rapid growth of the plants in early spring or in fall often result in outbreaks of mildew.

Control

Mildew is rarely serious enough to justify special control measures. Where this trouble has been serious in past years, partial control may be obtained by applications of 6–6–100 bordeaux mixture. These sprays should be started before any curling of the leaves to be most effective. Sulfur dust is effective against the mildew, but the danger of serious burning is so great that sulfur cannot be safely used in this State.

STRAWBERRY LEAF-ROLLER

(*Ancylis comptana* Frölich)

In the northern States and in Canada, strawberries are subject to injury from a small greenish or brownish caterpillar which folds the two halves of the leaflet together and, feeding within the shelter so formed, causes them to turn brown and die. While this insect is generally present in the strawberry fields of New York, it has been reported as causing important injury only in rare instances.

The insect hibernates both in the larval and pupal stages; the larvae in trash about the plants and the pupae in the folded leaves. The moths of the spring brood appear in May or early June and deposit their eggs on the strawberry leaves. The larvae feed for a few days openly on the upper surface of the leaf and then draw the two halves of the leaflet together. In New York there are at least two broods annually.

Control

Much can be done to hold the strawberry leaf-roller in check by spraying the plants twice with lead arsenate, 3 pounds in 100 gallons of water, making the first application just before the blossoms appear and the second after the crop has been harvested. This is intended to kill the young larvae feeding openly on the leaves before the leaves are folded. The spray will not kill the larvae in the folded leaves.

YELLOWS

(Cause unknown)

A new trouble in strawberries, particularly in the Premier variety, has become more prevalent in the past few years. It is recognized in early spring by the decidedly yellow color of the foliage. All plants in areas up to several feet of the rows may be affected. Premier plants are not seriously stunted and the foliage becomes green during the summer. Many other varieties are severely injured. The cause of this trouble is unknown.

Control

Precautions should be taken to avoid taking new sets from plants near the yellowed areas in the beds.

ROOT-ROTS

Many cases of stunting or death of strawberry plants are accompanied or preceded by more or less injury to the roots. Various workers have found a large number of different fungi in these injured roots and in many cases the injury was described as a *root-rot* caused by the particular fungus which was most plentiful at the time in that area. Extensive experiments carried

on in this State over a period of years indicate that, although many different fungi occur in injured roots, none of them is ordinarily able to cause appreciable injury to the roots of vigorous strawberry plants. Injured plants transplanted from areas of heavy loss usually recover when given good conditions for growth. Many apparent cases of root-rot in this State during the dry summer of 1933 entirely recovered when irrigation was practiced. Little trouble with root-rot has been experienced by growers who have obtained good plants locally and set them early in suitable soil.

If it is desirable to purchase plants from a section where the growing season starts earlier than most parts of New York State, experiments indicate it is best to obtain the plants while they are dormant and hold them in this condition until they are set in the field. If the plants are not allowed to dry out, they can be held satisfactorily for several months in cold storage at 32° F. This is a very convenient method of handling plants where cold-storage facilities are available, and appears to reduce root troubles to a minimum. The strawberry plants have a shallow root system made up of fine fibrous roots which are susceptible to injury from a large number of causes. Among the common types of injury are winter injury, drought, drowning, and chemical injury from excessive or improperly distributed fertilizers. When injury or death of roots occurs from any of these causes, various fungi in the soil enter the roots. While it is possible that root injury may result in some areas from fungi capable of attacking healthy roots, such instances are rare in this State.

STRAWBERRY ROOT-WORM

(*Paria canella* Fabricius)

The beetles of the strawberry root-worm hibernate in trash on the ground about the plants. They emerge in early spring, and eat out holes in the leaves of strawberry, red raspberry, and blackberry. The eggs are deposited during May and June among the fallen leaves on the ground. The grubs burrow through the ground feeding on the roots and become full-grown during July and August. They then transform to pupae and later to beetles in earthen cells in the ground. Most of the beetles emerge during August. After feeding for a time they go into hibernation.

No satisfactory method of controlling the strawberry root-worm has been devised. By practicing the one-crop system of strawberry culture the pest can be held down to a minimum and serious damage prevented.

WHITE GRUBS

White grubs are the large, thick-bodied, strongly curved, dirty, white larvae often found eating off the strawberry roots and killing the plants. They also often cause serious damage to red raspberries. They are the

larvae of the large brownish May beetles, or June bugs. These beetles appear in swarms in May and June. The females enter the soil to deposit their eggs. The eggs hatch in 10 to 18 days and the grubs feed on grass or strawberry roots for the remainder of the season. The grubs pass the winter in the soil at an average depth of about 10 inches from the surface. The following spring they return to the roots and complete their growth by June or July. They then construct earthen cells in which they transform to pupae and later to beetles. The beetles, however, do not emerge from the ground until the following spring. White grubs are likely to become abundant in old grass sod or in strawberry beds that are left down for several years.

Control

It is not advisable to plant strawberries on badly infested land, or on a newly plowed grass sod without growing an intervening cultivated crop for one season; owing to the lack of other food the grubs will concentrate their feeding on the strawberry roots and soon kill the plants. Much of the loss occasioned by white grubs can be avoided by adopting the one-crop system of strawberry culture and alternating with some crop more or less immune such as clover, beans, or peas.

When newly set plants show by their lack of vigor that a grub is attacking the roots, there is nothing to do but to dig it out and kill it.

CURRANTS AND GOOSEBERRIES

Among insects attacking currants and gooseberries, the most troublesome are the aphis, the imported currant worm, the gooseberry fruitworm, and the San José scale. The four-lined leaf-bug is more or less sporadic in its attacks. The currant stem-girdler is at present an important pest on only a few farms. Leaf-spots are common on both currants and gooseberries; powdery mildew is serious on some varieties of gooseberries.

Arsenical sprays or dusts cannot be used with safety on currants or gooseberries, owing to the dangers of objectionable spray residues. This danger may be prevented in currant or gooseberry plantings where these are the only crop; but where cherries, pears, and apples are interplanted, the residue problem is complicated. Washing methods have been developed which remove the residue, but these are not always satisfactory, particularly when the residues are heavy or if the fruit is washed after it has been put into storage and frozen.

It has been shown that all of the chewing insects affecting currants may be controlled with materials which do not leave objectionable residues. Therefore, if currants are grown by themselves or with other crops

requiring no arsenical treatment, there will be no danger from objectionable residues.

If the currants or gooseberries are grown among orchard trees, the residue danger may be reduced by the application of one or more of the following suggestions: (1) Wherever possible do not use arsenical sprays in currant or gooseberry plantings. (2) If an arsenical must be used on the tree crops, substitute calcium for lead arsenate. (3) Apply the minimum number of arsenical sprays to the tree crops before the currants are picked. (4) Prevent, as much as possible, the spray drift to the currant or gooseberry bushes. (5) Reduce to a minimum the amount or dosage for each application. (6) Do not use spray stickers, so that the poison will weather off more readily.

GOOSEBERRY FRUIT WORM

(*Zophodia grossulariae* Riley)

In recent years the gooseberry fruit-worm has caused considerable damage in certain gooseberry and currant plantings in the Hudson Valley. The insect hibernates in the pupal stage in the debris at the base of the bushes or beneath near-by stones and clumps of earth. The moths appear in the field during the last ten days in April and in early May. The adult females deposit their eggs in the open blossoms of both gooseberries and currants. The young larvae enter the developing berries and destroy the pulp. As the larvae grow they desert the first berries attacked and construct nests by tying together with delicate silken threads, several berry clusters and adjacent leaves (figure 1). The caterpillars feed on the berries until they are full-grown. About the middle of June the worms drop to the ground where they immediately seek shelter and pupate. There is only one brood annually.

Control

The gooseberry fruit-worm may be effectively controlled with thorough and timely applications of rotenone sprays or dusts. For light to moderate infestations one spray containing 3 pounds of powdered derris or cubé root (5-per-cent rotenone) in 100 gallons of water should be sufficient. The spray should be applied soon after the worms begin to draw the berries together. This is usually about 5 days after the calyx spray is begun for McIntosh apples. If rains follow soon after the treatment, or in cases of heavy infestation, a second application may be necessary. This should be made about 7 days after the first application. When dusts are used, the treatments should be made at about the same time as for sprays. A ½-per-cent rotenone dust made with a good grade of dusting sulfur, talc,

FIGURE 1. DAMAGE CAUSED BY THE GOOSEBERRY FRUIT-WORM ON CURRANT

or clay is suggested. It is unsafe to spray or dust currants or gooseberries with an arsenical because of the danger of objectionable residues.

SAN JOSÉ SCALE

(*Aspidiotus perniciosus* Comstock)

Currants are especially subject to infestation of the San José scale. It may be controlled on currants by spraying the plants while they are dor-

mant with the same materials as are used in orchards. For light infestations, liquid lime-sulfur, 1–8, may be used. For heavier infestations, where the scale is encrusted on the bark, oil sprays are more effective. A 2-per-cent lubricating-oil emulsion is safe and will give good results. Commercial miscible oils may be used, following the manufacturers' directions as to dilution. Spraying for scale control should be completed before the buds open in the spring, to avoid injury.

CURRANT APHIS

(*Capitophorus ribis* Linnaeus)

The currant aphis passes the winter in the egg stage on the twigs of the red currant, the black currant, and the gooseberry. It is an important pest only on the red currant and its varieties. The eggs hatch as the buds are opening and the young lice find their way to the underside of the first leaves. Here they soon reach maturity and begin to give birth to living young. At first all the lice are wingless, but, as the leaves become crowded, winged forms are produced which migrate to other leaves less heavily infested. Some individuals may go to some other summer host plants but enough remain on the currant so that breeding is continuous throughout the season.

Currant leaves infested by the lice become curled and distorted so that pocket-like cavities are formed on the under side. The upper side turns a bright red, variegated with yellow and green. Heavily infested plants may lose a large proportion of the leaves on the terminal shoot; the fruit does not ripen properly and may be stained by the honey-dew secreted by the lice.

Control

The currant aphis may be effectively and economically controlled by spraying with 1 pint of nicotine sulfate and 5 pounds of soap in 100 gallons of water, or dusting with a 3-per-cent-nicotine–lime dust. The first application should be made when the first leaves to unfold have the diameter of one-half to one inch. This kills the first generation of lice before they mature and begin to produce colonies of young. If this first application is made with thoroughness and care, it may not be necessary to repeat the treatment. If, however, the infestation is severe, additional applications may be necessary when the insect threatens to increase to destructive numbers. These treatments are likely to become necessary just before blossoming and about a month before picking.

The effectiveness of the treatment can be greatly increased by pruning so as to reduce the number of canes, thus keeping the bush open and not too compact and by removing all canes lying on or near the ground.

IMPORTED CURRANT WORM

(*Pteronus ribesii* Scopoli)

The adult of the currant worm is a small sawfly, about 1/3 of an inch in length, with the head and thorax more or less black and the abdomen yellowish. The eggs are deposited in rows along the principal veins on the under side of the leaves. The eggs of the first brood are laid soon after the leaves have expanded; those of the second brood in late June or early July.

At first the larvae (see cover illustration) feed in colonies of 30 or more on a leaf but they soon scatter to other parts of the plant. When numerous they are able to strip a bush of its leaves in a few days.

Control

It is unsafe to spray currants with an arsenical because of the residue left on the fruit and fruit stems. Sometimes currants acquire an excess of residue from the drip from overhanging apple trees even when the currants are not sprayed directly. Currant worms are very sensitive to rotenone insecticides and can be killed by dusts containing ½ of 1 per cent of this material. The dust should be applied as soon as the larvae hatch and begin feeding on the leaves. The dusting will be more effective if done under good weather conditions.

Liquid sprays are also effective at the rate of 2 pounds of finely powdered derris or cubé root (containing 4- or 5-per-cent rotenone) in 100 gallons of water.

Rotenone dusts and derris or cubé powder should not be combined with other materials of an alkaline nature, such as bordeaux mixture, lime, or copper-lime dust, since these materials tend to greatly reduce the efficiency of the rotenone, derris, or cubé.

LEAF SPOTS

(Caused by *Mycosphaerella grosulariae* (Fr.) Lindau, and *Pseudopeziza ribis* Klebahn)

Mycosphaerella leaf-spot is common in the State and often causes defoliation of red and white currants and gooseberries. A very similar leaf-spot caused by the fungus *Pseudopeziza ribis* may occasionally occur but is not serious. Defoliation caused by these diseases is more serious when it occurs before the crop is ripe.

Control

Although leaf-spots may cause considerable loss, local experience will determine whether spraying or their control is necessary. It is advisable

for most growers to use lime-sulfur 1–40 or 8–8–100 bordeaux mixture as the carrier for the nicotine in the aphis spray. In varieties and locations where leaf-spots have been serious, as many as five sprays at 2-weeks intervals may be required to prevent defoliation. Either lime-sulfur or bordeaux mixture may be used.

FOUR-LINED LEAF-BUG

(*Poecilocapsus lineatus* Fabricius)

The adult four-lined leaf-bug is about 1/3 inch in length; the general color of the body is bright orange-yellow, marked with four black stripes. The newly hatched nymphs are only about 1/20 inch in length and are bright vermillion red in color, with large black spots on the thorax. The full-grown nymph is bright orange-yellow, with black wing pads and a green stripe along the edge of the body. Both nymphs and adults attack the leaves of currants and gooseberries, puncturing the tissue and sucking out the juices. The injured areas turn brown and die, giving the leaf a spotted appearance. Severely injured leaves curl up and die; the growth of the shoot is checked and the tip may die.

The eggs of the four-lined leaf-bug are laid in late June and in early July in the soft, tender, new growth; they do not hatch until about the middle of May the following spring. It takes about a month for the nymphs to reach maturity. The greater part of the damage is done during June and in early July.

Control

The nymphs can be destroyed by careful and thorough spraying with 1 pint of nicotine sulfate and 4 pounds of soap in 100 gallons of water or by dusting, during the heat of the day when there is little wind, with a 4-per-cent-nicotine–lime dust.

CURRANT-STEM GIRDLER

(*Janus integer* Norton)

The currant-stem girdler has been injurious in practically all plantings in Chautauqua and in some of the plantings in the Hudson Valley. The adult is a sawfly about ½ inch in length; the body is black, the legs brownish yellow, the abdomen more or less yellowish. The adults appear the latter part of May. The female punctures one of the new canes a few inches from the tip and deposits an egg in the pith. She then girdles the cane about an inch above the egg, causing the tip to die and fall off. On hatching, the grub burrows downward in the pith for about 6 inches before becoming mature. It then forms a cocoon in the burrow, within which it passes the winter in the larval condition. It pupates in the spring and the adults emerge in May. There is only one generation a year.

Control

This pest can be effectively controlled by cutting off and destroying the infested canes. If this work is performed in May, only two or three inches of the tip need be removed. Later after the larvae have worked down in the pith it is necessary to remove about eight inches of the cane.

POWDERY MILDEW

(Caused by *Sphaerotheca mors-uvae* (Schw.) B. and C.)

Powdery mildew may be recognized by the white powdery appearance of the young unfolding leaves. European varieties are much more seriously stunted by mildew than are American varieties.

Control

In varieties and locations where mildew is serious, applications of lime-sulfur 1–40 should be started as growth begins and continued at two-weeks intervals for as many as five applications. Certain English varieties may be injured by applications of lime-sulfur. On such varieties the use of a wettable sulphur spray or a sulfur dust is suggested.

GRAPES

The principal diseases affecting grapes in New York are black rot, and powdery and downy mildew. Black rot occurs rather generally throughout the State. Powdery mildew is common in western New York and may appear in other areas, while downy mildew is prevalent only in the Finger Lakes region.

The grape leaf-hopper is widely distributed throughout the State. The berry-moth has been most troublesome in the Lake Erie region and the root-worm has, so far, been confined as a pest to that section. The rose chafer is destructive only in sandy regions.

POWDERY MILDEW

(Caused by *Uncinula necator* (Schw.) Burr.)

Powdery mildew is often destructive in the western New York grape belt and is occasionally serious in other parts of the State. The first spots of mildew appear on the green parts of the vine in early or mid-July. Soon some leaves are covered with the fungus and then it attacks the fruit clusters, spreading rapidly on the stalks and berry stems. By harvest these stems are withered and brown, the berries are dwarfed, and many of them covered with a thin white film of mildew. Probably the most serious loss is caused by the shelling of the berries on affected clusters both in the vineyard and in transportation.

Control

Sulfur dust is effective against powdery mildew but causes severe injury to the commercial varieties such as Concord, and cannot be recommended. The experimental work indicates that homemade 8–8–100 bordeaux mixture is the surest and safest fungicide for powdery-mildew control. It is superior to all commercial copper sprays so far tested and to copper-lime and bordeaux dusts. In the Chautauqua area two bordeaux sprays control the severest infections, but in the Niagara district three may be required. The first spray is applied as the berries begin to touch, with the subsequent sprays at two-weeks intervals. The addition of resin fish-oil soap at the rate of 3 pounds in 100 gallons of the bordeaux spray or of 1½ pints of Menhaden fish oil as a spreader and sticker is desirable for the first two sprays but should be omitted in later treatments to avoid spray residue.

DOWNY MILDEW

(Caused by *Plasmopara viticola* (B. and C.) Berl. and deToni)

Downy mildew is largely limited to the Finger Lakes region of central New York and particularly to the Keuka Lake area. It occasionally occurs in small amount on susceptible varieties in other parts of the State. Attacks may occur at any time from the blooming period until the grapes are picked. The first signs of the disease are small greenish yellow indefinite spots on the upper surface of the leaves. These spots gradually become brown, dry, and brittle. On the lower surface of the leaves similar spots appear which are soon covered with a downy white growth. The affected berries become hardened and grayish blue in color. Later the berries turn a livid brown or red and finally shrivel into mummies. Badly diseased fruits shell easily.

Control

Sprays of 8–8–100 bordeaux mixture have been found to be as effective as the stronger mixtures previously recommended. All of the copper-lime and bordeaux dusts tested have been found to be less effective. The most important single spray is usually one just before bloom. A second spray should be applied as soon as the blossoms are set in the Keuka area and a third spray just before the berries touch is often required and in some seasons a fourth spray may be needed about two weeks later. The addition of 3 pounds of resin fish-oil soap or 1½ pints of Menhaden fish oil in the third spray increases the spread of the spray over the berries. Spreaders shouldn't be used in later sprays because of the danger of residue. It is not practical to attempt the control of downy mildew after it has become established in the berry clusters.

BLACK ROT

(Caused by *Guignardia Bidwellii* (E.) Viala and Ravaz)

Black rot first appears on the fruit, where the berries are about half-grown, as a light area surrounded by a brownish line. The spot enlarges rapidly and becomes sunken and covered with many fine dark specks. The entire berry is soon involved and becomes a hard and shriveled mummy. Although the berries are most seriously affected, the disease often appears first on the leaves in June or July in the form of reddish brown rather circular spots. The centers of these spots soon turn gray and are studded with many fine black specks, the fruiting bodies of the fungus. All green parts of the vine may be attacked.

Control

Bordeaux mixture is the old established spray mixture. Where the disease has been serious in the past apply 10–10–100 bordeaux mixture: (1) when the second or third leaf appears; (2) before bloom; (3) just after bloom; (4) about 2 weeks later, and (5) about 4 weeks after the end of bloom.

In addition to spraying, control is aided by keeping the vineyard open for good circulation of air and by spring plowing to bury the fallen mummies as far as possible.

ROSE CHAFER

(*Macrodactylus subspinosus* Fabricius)

The rose chafer is an ungainly long-legged grayish brown beetle about ½ inch in length. The beetles invade the vineyards, often in swarms, about the middle of June or about the time grapes are ready to blossom. They feed on the blossom buds or blossoms and later attack the newly set fruit and the foliage. The beetles remain in the vineyard for ten days or two weeks and then migrate to other plants then in blossom.

Fortunately the rose chafer is restricted as a pest to sandy regions. The larva of the chafer is a grub that feeds on the roots of grasses in sandy soil. The female beetle will not enter the heavier soil for egg laying nor do the grubs thrive under such conditions. Vineyards on sandy soil should be kept free of grass. If a grass-sod has been allowed to develop under the rows and the roots are infested with larvae it should be cleaned out in the spring and the ground thoroughly cultivated in May and the first half of June to destroy as many as possible of the insects in the pupal stage. It is also well to keep as much as possible of the surrounding land in cultivated crops and to reduce to a minimum the area of waste grassland near the vineyard.

Control

The most effective method of control for the rose chafer is to spray the vine thoroughly on the first appearance of the beetles with the following mixture:

Confectioners' glucose	25 pounds
or cheap molasses	2 gallons
Lead arsenate	5 pounds
Water to make	100 gallons

If necessary, a second application may be made from 4 to 7 days later. Since the molasses or glucose destroys the adhesiveness of the poison, it is best to avoid spraying just before a rain. If a rain occurs within 24 hours after spraying, it may be necessary to repeat the application to renew the poison.

GRAPE ROOT-WORM

(*Fidia viticida* Walsh)

In New York State the grape root-worm has been a pest only in the Lake Erie region. There it has caused serious losses since 1900 and is still an important problem in many vineyards.

The larvae or grubs feed on the roots of the grapevines, eating off the root fibers and cutting out furrows or channels in the larger roots and main stem under ground. This injury to the roots causes the vine to take on a sickly stunted appearance, the leaves turn yellowish and may fall prematurely leaving the fruit to wither and drop. Sometimes the vines are killed outright.

The eggs of the grape root-worm are deposited under the loose bark on the old canes and trunk of the vine by a grayish brown beetle about ¼ inch in length. These beetles appear on the vines in late June and in July where they feed on the upper surface of the foliage, eating out characteristic chain-like markings in the leaves. Egg-laying usually begins the second week of July and is at its height the last of the month but a few eggs may be laid up to the first of September.

The eggs hatch in from 8 days to 2 weeks and the young grubs drop immediately to the ground. They soon work their way into the soil and begin feeding on the roots. Most of the grubs become full-grown by the last of October although a few do not reach maturity the first season. With the advent of cold weather in late October and November, the grubs descend in the soil to a depth of 10 inches to 2 feet. There they form earthen cells in which to pass the winter.

The following May the grubs move upward. Those that are not mature feed for a time on the vine roots. Early in June the grubs form earthen

cells in the soil from 4 to 10 inches below the surface. Here, between June 10 and 15, a large proportion of the grubs transform to pupae. The pupal stage lasts from 10 days to 2 weeks. During this period, the insect is in a helpless condition; if its cell is broken open, the pupa is unable to construct a new one and will perish. The pupae transform to beetles in their cells and after an interval of several days the adults emerge and begin feeding on the foliage of the vines. The first adults usually appear from June 20 to 25, but in backward seasons the emergence may be delayed until July 5. They feed for about 2 weeks or less on the foliage before beginning to deposit their eggs. The egg-laying period lasts for a month to 6 weeks.

Control

In the control of the grape root-worm two lines of attack are of value; the first is a modification of cultural practices intended to kill a large proportion of the pupae in the soil and the other aims to poison the beetles by spraying before they lay their eggs.

Destruction of the pupae. It is a common practice to plow the soil back to the vines at the last cultivation thus leaving a low ridge of earth under the row during the winter. This is usually removed in May with a horse-hoe. In vineyards where the root-worms are numerous it is a good plan to delay this horse-hoeing until a large proportion of the grubs have formed pupal cells, that is until the latter part of June. Disturbing the soil at this time will crush many of the pupae or break their cells, exposing the helpless pupae to the destructive effects of sunlight and to the attack of predaceous insects. If the hoeing is followed at once by a light harrowing to break up the lumps a larger proportion of the pupae will be killed. Under the best conditions this system will not kill all the pupae and should be supplemented by spraying if the vineyard is seriously infested.

Spraying to kill the beetles. The object of spraying is to kill the beetles before the eggs are laid. The kind of spray material to use will depend on the degree of infestation. If the beetles are not very numerous a spray application should be made within a week of the appearance of the first adults, using 3 pounds of lead arsenate in 100 gallons of 8–8–100 bordeaux mixture. The application should be repeated 10 days later. In vineyards severely infested and where the beetles are abundant it is better to use a sweetened poison spray. The most satisfactory mixture consists of 3 pounds of lead arsenate and 1 gallon of molasses in 100 gallons of water. This spray should be applied as soon as the beetles appear in numbers on the vines. Care should be taken not to apply the sweetened spray just before a rain; it does not adhere well to the foliage and will be largely washed off. It is best to apply this spray on warm sunny days when the

beetles are most active. About a week later a second spray should be applied, using this time 3 pounds of lead arsenate in 100 gallons of 8–8–100 bordeaux mixture without any molasses or other sweetening. The object of this schedule is to kill as many of the beetles as possible with the sweetened spray and then to repel the remaining beetles or those migrating in from adjoining vineyards with the lead arsenate and bordeaux.

To be effective against root-worm beetles the sprays must be applied at the proper time and with great thoroughness so as to cover all the foliage. Vineyards that regularly receive two applications of lead arsenate and bordeaux mixture, as indicated, rarely become seriously infested by the root-worm. This spray is also effective in the control of powdery mildew.

GRAPEVINE FLEA-BEETLE

(*Haltica chalybea* Illiger)

Just as the grape buds are ready to burst in the spring they are subject to attack by a small, glossy, greenish, or steel-blue beetle a little less than 1/5 inch in length that eats out the contents of the bud and thus destroys the future cane. Each beetle usually devours several buds and if the beetles are at all numerous the size of the crop may be seriously reduced. The beetles deposit their eggs under strips of loose bark on the old canes and the brownish, black-spotted grubs may be found during June and the first half of July feeding openly on the upper surface of the leaves. Pupation takes place in the ground. The beetles hibernate under fallen leaves and other rubbish in waste fields and in nearby woodlots. The part of the vineyard lying next to such waste land is most subject to injury. This is especially true if wild grape vines are allowed to grow there. The insect breeds undisturbed on the wild vines and the following spring the beetles move out into the vineyard.

Control

Wild grape vines should not be allowed to grow in the immediate vicinity of the vineyard. A thorough eradication of such breeding centers often solves the problem and renders other control measures unnecessary.

If in the spring the beetles are found on the vines, handpicking is the only method that will prevent the destruction of the buds. They may be jarred into a pan containing a little kerosense oil. The work of collecting the beetles must be done in the warmer part of bright sunny days while the beetles are most active, for in cold raw weather it is hard to find them. When alarmed the beetles feign death and drop at the slightest jar. Shaking the vines or jarring the trellis will cause them to fall, for some distance along the row. For this reason it is most satisfactory to use a small stick

about the size of a lead pencil with which to dislodge the beetles and make them fall into the pan of oil held beneath.

In vineyards where the infestation is serious and the grubs are on the leaves, it is a good plan to add from 2½ to 3 pounds of lead arsenate to each 100 gallons of the bordeaux mixture applied for disease control shortly before the blossoms open.

GRAPE LEAF-HOPPER

(*Erythroneura comes* Say)

The grape leaf-hopper is present in most vineyards of the State each year but only occasionally does it become abundant enough to warrant special spraying for its control. The adult hopper is scarcely 1/8 inch in length, pale in color, with back and wings marked with yellow and red. The insect hibnerates as an adult in the fallen leaves in woodlots and the thick grass in waste fields, along fences, hedgerows, and in swales and hollows. The hoppers emerge from hibernation about the first of May and feed on a large variety of plants, often to a large extent on bush fruits, until the grape leaves are well expanded, when they migrate to the vineyard. Here they feed almost exclusively on the under side of the leaves. Egg-laying begins about the first of June and continues for about a month. The eggs are inserted just beneath the lower epidermis of the leaf and are very difficult to see even with a lens. Hatching begins in late June and is usually practically complete by the middle of July, but the exact time varies considerably with the season. The nymphs require about a month to reach maturity and, like the adults, feed on the under side of the leaves. In unusually long and warm seasons two broods may develop, but usually the second brood is only partial. The greatest injury to the vines comes from the feeding of the adults and nymphs during August and September. The adults swarm over the vines, sucking the life from the leaves and smutting the fruit with their excrement. The injury to the foliage prevents the proper ripening of the fruit, which in consequence never acquires its proper color, flavor, or sweetness.

Control

If the hoppers are present in sufficient numbers to actually threaten important injury to the crop, special measures should be taken for their control. Unless they are extremely abundant, however, spraying is not likely to be profitable. The nymphs are very sensitive to nicotine sprays. The most practical method of control consists in spraying for the destruction of the first brood of nymphs in early July, using the following material:

Bordeaux mixture (8–8–100)	
Nicotine sulfate	½ pint
Menhaden fish oil	1 pint
Water to make	100 gallons

The application should be made when the eggs have nearly all hatched and the insects are largely in the nymph stage. It should be remembered that the nymphs are all on the under side of the leaves where it is difficult to hit them with the spray. If the spray is directed horizontally into the vines as in ordinary grape spraying, the edge of the leaf is bent down like an umbrella and protects the hoppers from the liquid. An up-turned nozzle must be used and great care taken to hit the under side of the leaves. Where the vines are trained low, as in the Finger Lakes region, spraying with fixed nozzles does practically no good, the nicotine is wasted and the entire operation is unprofitable. Where the vines are trained higher and the new canes extend out into the row, spraying with fixed nozzles is of some value, but the best results are obtained by using an angle nozzle on a short extension rod. It is best to have two men do the spraying, one on each row. If one hose is about 15 feet long and the other about 25 feet, the operators can keep out of each other's way and avoid being drenched with the spray.

If it becomes evident early in the season that the hoppers are going to be excessively abundant it will pay to defer suckering the vines till the last of June. When the suckers are broken out at that time a great number of eggs and newly hatched nymphs will be destroyed with the drying up of the leaves.

It is also a good plan to burn off the dead grass on the headlands, on gully banks, and in waste fields adjoining vineyards very early in the spring to destroy over-wintering adults.

GRAPE-BERRY MOTH

(*Polychrosis viteana* Clemens)

Although the grape-berry moth is present in small numbers in most vineyards of the State each year, destructive outbreaks have occurred only in the Chautauqua area. In some instances the infestation seems to be general throughout the region, but more often it is more or less sporadic, being confined to certain vineyards or parts of vineyards.

The grape-berry moth passes the winter in the pupal state in its cocoon. The larva forms its cocoon by cutting out a small piece of the leaf and folding it over to form a cavity which it lines with silk. The cocoon is connected with the leaf at each end by a small, uncut piece of leaf tissue. The cocoons of the first brood are all made in green leaves on the vine and usually re-

main in place until the moth emerges. Many of the second-brood larvae, however, do not form cocoons on leaves on the vine but descend by a silken thread to the ground where they make these structures on the fallen leaves. Many of the leaves dry out and blow away but a large number of the cocoons become loosened from the leaves and remain on the ground. The pupae in these cocoons are killed by temperatures below 10° F. If the ground remains covered by snow during the winter, the pupae are protected from the cold and an abundance of moths are likely to emerge the following spring. The insect is more likely to survive in parts of the vineyard where snow drifts form in hollows or in the lee of hedges, fences, and other obstructions.

The small purplish brown moths emerge about June 1 and deposit their thin, rounded, scale-like eggs on the stems of the blossom clusters. Some of the larvae hatch and begin feeding before the blossoms open. They make a slight web among the blossom buds. They feed on the buds, blossoms, and newly set berries. Unless the insects are extremely abundant, the work of the first brood of larvae is likely to pass unnoticed. These first-brood larvae become full-grown by July 1 and then crawl to the leaves, where they construct cocoons and pupate. A second brood of moths begins to appear during the latter half of July. These moths deposit eggs on the berries or on the stems and the larvae hatching from them feed largely in the green grapes during July and August. A larva will often leave one berry and enter a second or third, webbing them together with a few threads of silk. A partial third brood of larvae may develop in late August and September. The different broods overlap so that after midsummer all stages of the insect may be found at the same time.

Control

A large part of the losses caused by the berry moth can be avoided by adopting such measures as will prevent the formation of snow drifts in the vineyard. In some cases this will require the removal of fences or hedges or the cutting down of trees in adjoining woodlots for a distance of about 100 feet from the edge of the vineyard. Where the drifts form in hollows or in the lee of buildings that cannot be removed, it would be better to take up the vineyard and use the land for some other crop.

Fall-plowing of the vineyard gives protection to the overwintering pupae and tends to increase the degree of infestation the following year. It is not a good practice to follow in regions where the berry moth is a problem.

If spraying is found necessary for the protection of the crop, a special application should be made just before blossoming and again as soon as the fruit has set, using:

Bordeaux mixture (8–8–100)	
Lead arsenate	3 pounds
Resin fish-oil soap	3 pounds
Water to make	100 gallons

A special effort should be made to place the spray on the clusters.

THE GRAPE PLUME-MOTH

(*Oxyptilus periscelidactylus* Fitch)

Often garden vineyards and occasionally commercial grape plantings in the Hudson Valley become infested with greenish, white-haired caterpillars of the grape plume-moth. The caterpillars feed inside nests formed by their pulling the edges of one or several leaves together and loosely tying them in place with silken threads. In addition to feeding on the foliage, the larvae sometimes attack the blossom clusters. The "woolly" looking worms appear in early May and by late May or early June they are full-grown, when they pupate. The adult moths emerge about 7 to 10 days after pupation. There is probably only one brood each year.

Control

While the grape plume-moth apparently does not cause appreciable injury in well-sprayed commercial vineyards, nevertheless poorly sprayed vineyards and garden plantings may become heavily infested. Such infestations are readily controlled by spraying with a mixture consisting of 3 pounds of ground derris or cubé root (4-per-cent rotenone) and 1 pound of powdered skimmilk in 100 gallons of water. This spray should be applied as soon as the worms appear, which is usually before May 15.

Fruit in Season

NEW YORK FRUIT has always held a favorable position among those who know flavor and quality. Naturally, the College of Agriculture and the Cornell University Agricultural Experiment Station have studied the problems of fruit growing, and have printed a number of bulletins on the subject. A few of these are:

E 199 **Growing fruit for home use** *Oskamp*

E 246 **Cherry growing in New York** *Peck*

E 312 **Tree bracing and wound treatment in the orchard** *MacDaniels*

P 573 **Nut-growing in New York State** *MacDaniels*

The foregoing titles represent only a few of the 35 publications that relate to fruits.

Copies of the bulletins listed will be sent on request to the

Office of Publication
College of Agriculture
Ithaca, New York

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